Chemical and Biomolecular Engineering

At Berkeley, graduate work in chemical and biomolecular engineering emphasizes the excitement of original research in frontier areas of applied science. Graduate students may pursue a PhD in Chemical Engineering, or they may apply to the Product Development Program to obtain an MS in Chemical Engineering. While formal courses are necessary to provide scientific fundamentals and intellectual breadth, the primary characteristic of Berkeley's graduate experience is to participate in the quest for new knowledge. Graduate students and faculty collaborate as partners in scholarship, in learning, and in intellectual discovery.

Master's Program

Professional Degree in Product Development Program (MS)

The PDP is a graduate-level degree program whose central aim is to fill the unmet need at national and international levels for graduates of chemical engineering and related disciplines who have knowledge and field experience in the complex process of transforming technical innovations into commercially successful products. In the space of one calendar year, PDP graduates will gain exposure to real-world product development practices in a range of chemical process-intensive industries including biotechnology, microelectronics, nanoscience, and consumer products (concentrations within the program). The PDP does not require a research thesis, but students will find completing the extensive coursework and field study assignment challenging. By combining elements of advanced technical knowledge with focused business-related training, the PDP aims to fill a specific niche in the "choice space" of graduate education options for engineering graduates.

M.S. in Chemical Engineering

Focusing on Chemical Engineering core courses and higher division electives this highly competitive program will test students on a) transport phenomena; b) kinetics and chemical fundamentals; and c) thermodynamics at the end of the first semester.

PhD Program

The PhD program is designed to enlarge the body of knowledge of the student and, more importantly, to discover and develop talent for original, productive, and creative work in chemical and biomolecular engineering. Breadth of knowledge and professional training are achieved through advanced course work. To develop the creative talents of the student, a paramount emphasis in the PhD program is placed on intensive research, productive, and creative work in chemical and biomolecular engineering.

PhD students may choose to add a designated emphasis (DE) to their program. A designated emphasis is a specialization, such as a new method of inquiry or an important field of application, which is relevant to two or more existing doctoral degree programs. Designated emphases open to students in this PhD program include: Nanoscale Science and Engineering (NSE); Energy Sciences and Technology (DEEST); Communication, Computation and Statistic; Computational and Genomic Biology; and New Media.

Admission to the University

Minimum Requirements for Admission

The following minimum requirements apply to all graduate programs and will be verified by the Graduate Division:

1. A bachelor’s degree or recognized equivalent from an accredited institution;
2. A grade point average of B or better (3.0);
3. If the applicant comes from a country or political entity (e.g., Quebec) where English is not the official language, adequate proficiency in English to do graduate work, as evidenced by a TOEFL score of at least 90 on the iBT test, 570 on the paper-and-pencil test, or an IELTS Band score of at least 7 on a 9-point scale (note that individual programs may set higher levels for any of these); and
4. Sufficient undergraduate training to do graduate work in the given field.

Applicants Who Already Hold a Graduate Degree

The Graduate Council views academic degrees not as vocational training certificates, but as evidence of broad training in research methods, independent study, and articulation of learning. Therefore, applicants who already have academic graduate degrees should be able to pursue new subject matter at an advanced level without the need to enroll in a related or similar graduate program.

Programs may consider students for an additional academic master's or professional master’s degree only if the additional degree is in a distinctly different field.

Applicants admitted to a doctoral program that requires a master’s degree to be earned at Berkeley as a prerequisite (even though the applicant already has a master's degree from another institution in the same or a closely allied field of study) will be permitted to undertake the second master’s degree, despite the overlap in field.

The Graduate Division will admit students for a second doctoral degree only if they meet the following guidelines:

1. Applicants with doctoral degrees may be admitted for an additional doctoral degree only if that degree program is in a general area of knowledge distinctly different from the field in which they earned their original degree. For example, a physics PhD could be admitted to a doctoral degree program in music or history; however, a student with a doctoral degree in mathematics would not be permitted to add a PhD in statistics.
2. Applicants who hold the PhD degree may be admitted to a professional doctorate or professional master's degree program if there is no duplication of training involved.

Applicants may apply only to one single degree program or one concurrent degree program per admission cycle.

Required Documents for Applications

1. Transcripts: Applicants may upload unofficial transcripts with your application for the departmental initial review. If the applicant is admitted, then official transcripts of all college-level work will be required. Official transcripts must be in sealed envelopes as issued by the school(s) attended. If you have attended Berkeley, upload
your unofficial transcript with your application for the departmental initial review. If you are admitted, an official transcript with evidence of degree conferred will not be required.

2. **Letters of recommendation:** Applicants may request online letters of recommendation through the online application system. Hard copies of recommendation letters must be sent directly to the program, not the Graduate Division.

3. **Evidence of English language proficiency:** All applicants from countries or political entities in which the official language is not English are required to submit official evidence of English language proficiency. This applies to applicants from Bangladesh, Burma, Nepal, India, Pakistan, Latin America, the Middle East, the People’s Republic of China, Taiwan, Japan, Korea, Southeast Asia, most European countries, and Quebec (Canada). However, applicants who, at the time of application, have already completed at least one year of full-time academic course work with grades of B or better at a US university may submit an official transcript from the US university to fulfill this requirement. The following courses will not fulfill this requirement:

- courses in English as a Second Language,
- courses conducted in a language other than English,
- courses that will be completed after the application is submitted, and
- courses of a non-academic nature.

If applicants have previously been denied admission to Berkeley on the basis of their English language proficiency, they must submit new test scores that meet the current minimum from one of the standardized tests. Official TOEFL score reports must be sent directly from Educational Test Services (ETS). The institution code for Berkeley is 4833. Official IELTS score reports must be mailed directly to our office from the British Council. TOEFL and IELTS score reports are only valid for two years.

**Where to Apply**

Visit the Berkeley Graduate Division application page ([http://grad.berkeley.edu/admissions/apply](http://grad.berkeley.edu/admissions/apply)).

**Admission to the Program**

Admission is granted by the University's Graduate Division on the recommendation of the department. Applicants generally are required to provide the following: evidence of superior performance in the last two years of undergraduate studies; test scores for the aptitude portion of the Graduate Record Examination (the advanced GRE or subject test is not required); and three letters of recommendation from professors or colleagues familiar with the applicant's academic and professional aptitudes. International students whose native language is not English must provide evidence of English language proficiency. The weight of evidence from all sources determines admission. Students do not need a master's degree to apply for a doctoral degree. Most applicants will have completed a typical undergraduate program in chemical engineering. However, admission may be granted to students with undergraduate degrees in a related discipline. In this case, necessary background courses in chemical engineering are taken as part of the program for the first year.

**Curriculum**

A total of 18 units of letter-graded graduate courses must be taken during residence in the graduate program. In the first semester, a minimum of 9 units must be obtained from the core chemical engineering courses in the areas of mathematics, thermodynamics, reaction engineering, and transport phenomena. In addition, students are required to take the CHM ENG 375 pedagogy course and two semesters in CHM ENG 300. Students should be registered full time with a minimum of 12 units. These include CHM ENG 299 and colloquium series CHM ENG 298.

<table>
<thead>
<tr>
<th>9 units: Chemical Engineering graduate core courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM ENG 230 Mathematical Methods in Chemical Engineering</td>
</tr>
<tr>
<td>CHM ENG 240 Thermodynamics for Chemical Product and Process Design</td>
</tr>
<tr>
<td>CHM ENG 244 Kinetics and Reaction Engineering</td>
</tr>
<tr>
<td>CHM ENG 245 Catalysis</td>
</tr>
<tr>
<td>CHM ENG 250 Transport Processes</td>
</tr>
<tr>
<td>CHM ENG 274 Biomolecular Engineering</td>
</tr>
</tbody>
</table>

| 9-12 units: Graduate or upper division electives |

**Professional Master's with Product Development Concentration**

The Master's PDP program places equal emphasis on advanced course work in new product development principles, specific industry practices, and the field study assignment. Successful completion of each of these elements is a prerequisite to graduation. The specific courses taken in the PDP program are selected in consultations between the student, the PDP executive director, and a faculty adviser. Upon entrance to the program, students will be required to declare an industry area specialization so that an appropriate academic schedule can be constructed. Students must complete a minimum of 28 units with at least 18 of those units from letter-graded courses which include a minimum of 12 units in graduate-level (i.e., 200 series) courses.

Specific coursework to pursue an industry track will vary based on the individual student's interests and the availability of course offerings in a given year.

For examples of representative curricula for each industry track, please visit:

[http://chemistry.berkeley.edu/grad/cbe/pdp/graduation-requirements](http://chemistry.berkeley.edu/grad/cbe/pdp/graduation-requirements)

**M.S. in Chemical Engineering**

Highly competitive admission and program. Students have to complete a total of 24 semester units are required for the MS. Of the 24 units, Academic Senate regulations state that a minimum of 12 units must be in 200-level courses in Chemical Engineering (230, 240, 244, 250 and 274). Additional 12 units in upper division/graduate courses electives as approved by our Graduate Advisor and 6 units in 298 and 299.

There is a comprehensive exam given by at least 2 Senate faculty testing on a) transport phenomena; b) kinetics and chemical fundamentals; and c) thermodynamics at the end of the first semester. Time for completion of the degree is 2 semesters.

**Chemical and Biomolecular Engineering**

Expand all course descriptions [+ ]Collapse all course descriptions [-]
CHM ENG 230 Mathematical Methods in Chemical Engineering 3 Units
Terms offered: Fall 2018, Fall 2017, Fall 2014
The course aims to introduce a variety of mathematical and computational methods useful in solving research problems pertaining to chemical and biomolecular systems. The course covers a wide range of topics from linear algebra and matrices, differential equations, and stochastic methods. Even though the focus is primarily on analytical methods, most of the concepts will be demonstrated with computations and applications. The goal of the course is to ensure that the students are aware of a wide range of computational methods that can be useful in their research and to provide the students with sufficient background in applied mathematics that can be useful in reading the science and engineering literature.

Mathematical Methods in Chemical Engineering: Read More [+]

Rules & Requirements
Prerequisites: Math 53 and 54 or equivalent; open to seniors with consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.

Mathematical Methods in Chemical Engineering: Read Less [-]

CHM ENG 240 Thermodynamics for Chemical Product and Process Design 3 Units
Terms offered: Fall 2019, Fall 2018, Fall 2017
Topics covered include molecular thermodynamics of pure substances and mixtures, interfacial thermodynamics, statistical mechanics, and computer simulations.

Thermodynamics for Chemical Product and Process Design: Read More [+]

Rules & Requirements
Prerequisites: Math 53 and 54 or equivalent; 141 or equivalent; open to seniors with consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.

Thermodynamics for Chemical Product and Process Design: Read Less [-]

CHM ENG 244 Kinetics and Reaction Engineering 3 Units
Terms offered: Fall 2019, Fall 2018, Fall 2017
Molecular processes in chemical systems, kinetics and catalysis.

Kinetics and Reaction Engineering: Read More [+]

Rules & Requirements
Prerequisites: 142 or equivalent; open to seniors with consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.

Kinetics and Reaction Engineering: Read Less [-]

CHM ENG 245 Catalysis 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2016
Adsorption and kinetics of surface reactions; catalyst preparation and characterization; poisoning, selectivity, and empirical activity patterns in catalysis; surface chemistry, catalytic mechanisms and modern experimental techniques in catalytic research; descriptive examples of industrial catalytic systems.

Catalysis: Read More [+]

Rules & Requirements
Prerequisites: 244 or Chemistry 223, or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.

Catalysis: Read Less [-]
CHM ENG 246 Principles of Electrochemical Engineering 3 Units
Terms offered: Spring 2012, Fall 2010, Fall 2009
Electrode processes in electrolysis and in galvanic cells. Charge and mass transfer in ionic media. Criteria of scale-up.
Principles of Electrochemical Engineering: Read More [+]
Rules & Requirements
Prerequisites: Graduate standing or consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Principles of Electrochemical Engineering: Read Less [-]

CHM ENG 248 Applied Surface and Colloid Chemistry 3 Units
Terms offered: Spring 2014, Spring 2012, Spring 2010
Principles of surface and colloid chemistry with current applications; surface thermodynamics, wetting, adsorption from solution, disperse systems, association colloids, interacting electrical double layers and colloid stability, kinetics of coagulation, and electrokinetics.
Applied Surface and Colloid Chemistry: Read More [+]
Rules & Requirements
Prerequisites: Graduate standing or consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Applied Surface and Colloid Chemistry: Read Less [-]

CHM ENG 250 Transport Processes 3 Units
Terms offered: Fall 2019, Fall 2018, Fall 2017
Basic differential relations of mass, momentum, and energy including creeping, laminar, and turbulent flow, boundary layers, convective-diffusion in heat and mass transfer, and simultaneous multicomponent mass and energy transport. Analytic mathematical solution of the equations of change using classical techniques including: separation of variables, similarity solutions, and Laplace and Fourier transforms.
Transport Processes: Read More [+]
Rules & Requirements
Prerequisites: Chemical & Biomolecular Engineering 150A, 150B; Mathematics 53 and 54, or equivalent; open to seniors with consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Transport Processes: Read Less [-]

CHM ENG 256 Advanced Transport Phenomena 3 Units
Terms offered: Fall 2018, Fall 2016, Spring 2009
Formulation and rigorous analysis of the laws governing the transport of momentum, heat, and mass, with special emphasis on chemical engineering applications. Detailed investigation of laminar flows complemented by treatments of turbulent flow systems and hydrodynamic stability.
Advanced Transport Phenomena: Read More [+]
Rules & Requirements
Prerequisites: 230
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Advanced Transport Phenomena: Read Less [-]
**CHM ENG C268 Physicochemical Hydrodynamics 3 Units**

Terms offered: Spring 2017, Fall 2013, Fall 2011, Spring 2011


Time and Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

**Additional Details**
- **Subject/Course Level:** Chemical & Biomolecular Engineering/Graduate
- **Grading:** Letter grade.
- **Instructor:** Morris
- **Also listed as:** MEC ENG C268

**Physicochemical Hydrodynamics: Read More [+]**

**Rules & Requirements**
- **Prerequisites:** A first graduate course in fluid mechanics such as 260A-260B

---

**CHM ENG C270 Protein Engineering 3 Units**

Terms offered: Fall 2015, Fall 2014, Fall 2010

An in-depth study of the current methods used to design and engineer proteins. Emphasis on how strategies can be applied in the laboratory. Relevant case studies presented to illustrate method variations and applications. Intended for graduate students.

Time and Format

**Fall and/or spring:** 15 weeks - 3 hours of lecture per week

**Additional Details**
- **Subject/Course Level:** Chemical & Biomolecular Engineering/Graduate
- **Grading:** Letter grade.
- **Instructor:** Tullman-Ercek
- **Also listed as:** BIO ENG C219

**Protein Engineering: Read More [+]**

**Rules & Requirements**
- **Prerequisites:** Graduate standing or consent of instructor

---

**CHM ENG 274 Biomolecular Engineering 3 Units**

Terms offered: Spring 2019, Spring 2018, Fall 2015


**Biomolecular Engineering: Read More [+]**

**Rules & Requirements**
- **Prerequisites:** Graduate standing or consent of instructor

---

**CHM ENG 293C Curricular Practical Training Internship 0.0 Units**

Terms offered: Prior to 2007

This is an independent study course for international students doing internships under the Curricular Practical Training program.

**Curricular Practical Training Internship: Read More [+]**

**Rules & Requirements**
- **Repeat rules:** Course may be repeated for credit without restriction.

**Hours & Format**
- **Summer:** 8 weeks - 0 hours of independent study per week

**Additional Details**
- **Subject/Course Level:** Chemical & Biomolecular Engineering/Graduate
- **Grading:** Offered for satisfactory/unsatisfactory grade only.

**Curricular Practical Training Internship: Read Less [-]**
CHM ENG C294A Mechanics and Physics of Lipid Bilayers 3 Units
Terms offered: Fall 2017
Lipid bilayers constitute the membrane that encloses every animal cell and many of its interior structures, including the nuclear envelope, the organelles and the endoplasmic reticulum. This is a unique course devoted to modern developments in this exceptionally active field of research, ranging from models based on continuum theory to recent developments based on statistical mechanics.

Objectives & Outcomes
Student Learning Outcomes: To expose students to advanced current work on the mechanics and physics of lipid bilayers (a very active field of current research relevant to biomechanics and biophysics)

Rules & Requirements
Prerequisites: Mechanical Engineering 185 or equivalent

CHM ENG 295B Special Topics in Chemical Engineering: Electrochemical, Hydrodynamic, and Interfacial Phenomena 2 Units
Terms offered: Fall 2011, Spring 2011, Fall 2004
Current and advanced study in chemical engineering, primarily for advanced graduate students.

Rules & Requirements
Prerequisites: Open to properly qualified graduate students
Repeat rules: Course may be repeated for credit without restriction.

CHM ENG 295K Design of Functional Interfaces 3 Units
Terms offered: Spring 2011, Spring 2005, Fall 2004
This course introduces students to the concepts and techniques involved in the design and physical characterization of advanced functional materials consisting of well-defined interfaces. Throughout the course, principles of supramolecular chemistry on solid surfaces are applied to functional systems. Materials with different connectivity and structure at the active site are compared for development of understanding. Specific topics include catalysis, separations, encapsulation, and biomedicine.

Rules & Requirements
Prerequisites: Graduate standing

CHM ENG 295N Polymer Physics 3 Units
Terms offered: Spring 2015, Spring 2010, Spring 2008
This course, which is based on Gert Strobl's book addresses the origin of some of the important physical properties of polymer liquids and solids. This includes phase transitions, crystallization, morphology of multiphase polymer systems, mechanical properties, response to mechanical and electric fields, and fracture. When possible, we will develop quantitative molecular models that predict macroscopic behavior. The course will address experimental data obtained by microscopy, light and neutron scattering, rheology, and dielectric relaxation.

Rules & Requirements
Prerequisites: 230 and 240

CHM ENG 295P Design of Functional Interfaces 3 Units
Terms offered: Spring 2011, Spring 2005, Fall 2004
This course introduces students to the concepts and techniques involved in the design and physical characterization of advanced functional materials consisting of well-defined interfaces. Throughout the course, principles of supramolecular chemistry on solid surfaces are applied to functional systems. Materials with different connectivity and structure at the active site are compared for development of understanding. Specific topics include catalysis, separations, encapsulation, and biomedicine.

Rules & Requirements
Prerequisites: Graduate standing

CHM ENG 295Q Polymer Physics 3 Units
Terms offered: Spring 2015, Spring 2010, Spring 2008
This course, which is based on Gert Strobl's book addresses the origin of some of the important physical properties of polymer liquids and solids. This includes phase transitions, crystallization, morphology of multiphase polymer systems, mechanical properties, response to mechanical and electric fields, and fracture. When possible, we will develop quantitative molecular models that predict macroscopic behavior. The course will address experimental data obtained by microscopy, light and neutron scattering, rheology, and dielectric relaxation.

Rules & Requirements
Prerequisites: 230 and 240

CHM ENG 295R Design of Functional Interfaces 3 Units
Terms offered: Spring 2011, Spring 2005, Fall 2004
This course introduces students to the concepts and techniques involved in the design and physical characterization of advanced functional materials consisting of well-defined interfaces. Throughout the course, principles of supramolecular chemistry on solid surfaces are applied to functional systems. Materials with different connectivity and structure at the active site are compared for development of understanding. Specific topics include catalysis, separations, encapsulation, and biomedicine.

Rules & Requirements
Prerequisites: Graduate standing

CHM ENG 295S Polymer Physics 3 Units
Terms offered: Spring 2015, Spring 2010, Spring 2008
This course, which is based on Gert Strobl's book addresses the origin of some of the important physical properties of polymer liquids and solids. This includes phase transitions, crystallization, morphology of multiphase polymer systems, mechanical properties, response to mechanical and electric fields, and fracture. When possible, we will develop quantitative molecular models that predict macroscopic behavior. The course will address experimental data obtained by microscopy, light and neutron scattering, rheology, and dielectric relaxation.

Rules & Requirements
Prerequisites: 230 and 240

CHM ENG 295T Design of Functional Interfaces 3 Units
Terms offered: Spring 2011, Spring 2005, Fall 2004
This course introduces students to the concepts and techniques involved in the design and physical characterization of advanced functional materials consisting of well-defined interfaces. Throughout the course, principles of supramolecular chemistry on solid surfaces are applied to functional systems. Materials with different connectivity and structure at the active site are compared for development of understanding. Specific topics include catalysis, separations, encapsulation, and biomedicine.

Rules & Requirements
Prerequisites: Graduate standing

CHM ENG 295U Polymer Physics 3 Units
Terms offered: Spring 2015, Spring 2010, Spring 2008
This course, which is based on Gert Strobl's book addresses the origin of some of the important physical properties of polymer liquids and solids. This includes phase transitions, crystallization, morphology of multiphase polymer systems, mechanical properties, response to mechanical and electric fields, and fracture. When possible, we will develop quantitative molecular models that predict macroscopic behavior. The course will address experimental data obtained by microscopy, light and neutron scattering, rheology, and dielectric relaxation.

Rules & Requirements
Prerequisites: 230 and 240

CHM ENG 295V Design of Functional Interfaces 3 Units
Terms offered: Spring 2011, Spring 2005, Fall 2004
This course introduces students to the concepts and techniques involved in the design and physical characterization of advanced functional materials consisting of well-defined interfaces. Throughout the course, principles of supramolecular chemistry on solid surfaces are applied to functional systems. Materials with different connectivity and structure at the active site are compared for development of understanding. Specific topics include catalysis, separations, encapsulation, and biomedicine.

Rules & Requirements
Prerequisites: Graduate standing

CHM ENG 295W Polymer Physics 3 Units
Terms offered: Spring 2015, Spring 2010, Spring 2008
This course, which is based on Gert Strobl's book addresses the origin of some of the important physical properties of polymer liquids and solids. This includes phase transitions, crystallization, morphology of multiphase polymer systems, mechanical properties, response to mechanical and electric fields, and fracture. When possible, we will develop quantitative molecular models that predict macroscopic behavior. The course will address experimental data obtained by microscopy, light and neutron scattering, rheology, and dielectric relaxation.

Rules & Requirements
Prerequisites: 230 and 240

CHM ENG 295X Design of Functional Interfaces 3 Units
Terms offered: Spring 2011, Spring 2005, Fall 2004
This course introduces students to the concepts and techniques involved in the design and physical characterization of advanced functional materials consisting of well-defined interfaces. Throughout the course, principles of supramolecular chemistry on solid surfaces are applied to functional systems. Materials with different connectivity and structure at the active site are compared for development of understanding. Specific topics include catalysis, separations, encapsulation, and biomedicine.

Rules & Requirements
Prerequisites: Graduate standing

CHM ENG 295Y Polymer Physics 3 Units
Terms offered: Spring 2015, Spring 2010, Spring 2008
This course, which is based on Gert Strobl's book addresses the origin of some of the important physical properties of polymer liquids and solids. This includes phase transitions, crystallization, morphology of multiphase polymer systems, mechanical properties, response to mechanical and electric fields, and fracture. When possible, we will develop quantitative molecular models that predict macroscopic behavior. The course will address experimental data obtained by microscopy, light and neutron scattering, rheology, and dielectric relaxation.

Rules & Requirements
Prerequisites: 230 and 240

CHM ENG 295Z Design of Functional Interfaces 3 Units
Terms offered: Spring 2011, Spring 2005, Fall 2004
This course introduces students to the concepts and techniques involved in the design and physical characterization of advanced functional materials consisting of well-defined interfaces. Throughout the course, principles of supramolecular chemistry on solid surfaces are applied to functional systems. Materials with different connectivity and structure at the active site are compared for development of understanding. Specific topics include catalysis, separations, encapsulation, and biomedicine.

Rules & Requirements
Prerequisites: Graduate standing
CHM ENG 295P Special Topics in Chemical Engineering: Introduction to New Product Development 3 Units
Terms offered: Fall 2019, Fall 2018, Fall 2016
This course is part of the product development initiative sponsored by the department of chemical engineering. It focuses on real-life practices and challenges of translating scientific discovery into commercial products. Its scope is limited in most circumstances to situations where some knowledge of chemical engineering, chemistry, and related disciplines might prove to be particularly useful. The course primarily uses case studies of real-world new product development situations to simulate the managerial and technical challenges that will confront students in the field. We will cover a wide range of topics including basic financial, strategic and intellectual property concepts for products, managing risk and uncertainty, the effective new product development team, the evolving role of corporate R&D, the new venture product company and the ethics of post-launch product management.

Rules & Requirements
Prerequisites: Graduate standing or consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructor: Alexander

Special Topics in Chemical Engineering: Introduction to New Product Development: Read Less [-]

CHM ENG 295Q Special Topics in Chemical Engineering: Advanced Topics in New Product Development 3 Units
Terms offered: Spring 2019, Spring 2018, Spring 2016
This course is a part of the product development initiative sponsored by the department of chemical engineering. The course builds on the coverage in 295P of real-life practices of translating scientific discovery into commercial products. We will cover a wide range of advanced product development concepts including technology road maps, decision analysis, six sigma, product portfolio optimization, and best practices for field project management.

Rules & Requirements
Prerequisites: Graduate standing or consent of instructor. 295P recommended

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructor: Alexander

Special Topics in Chemical Engineering: Advanced Topics in New Product Development: Read Less [-]
CHM ENG C295A The Berkeley Lectures on Energy: Energy from Biomass 3 Units
Terms offered: Fall 2015, Fall 2014, Fall 2013
After an introduction to the different aspects of our global energy consumption, the course will focus on the role of biomass. The course will illustrate how the global scale of energy guides the biomass research. Emphasis will be places on the integration of the biological aspects (crop selection, harvesting, storage, and distribution, and chemical composition of biomass) with the chemical aspects to convert biomass to energy. The course aims to engage students in state-of-art research.
The Berkeley Lectures on Energy: Energy from Biomass: Read More [+]
Rules & Requirements
Prerequisites: Biology 1A; Chemistry 1B or 4B, Mathematics 1B
Repeat rules: Course may be repeated for credit under special circumstances: Repeatable when topic changes with consent of instructor.
Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructors: Bell, Blanch, Clark, Smit, C. Somerville
Also listed as: BIO ENG C281/CHEM C238/PLANTBI C224
The Berkeley Lectures on Energy: Energy from Biomass: Read Less [-]

CHM ENG C295L Implications and Applications of Synthetic Biology 3 Units
Terms offered: Spring 2007
Explore strategies for maximizing the economic and societal benefits of synthetic biology and minimizing the risks; create "seedlings" for future research projects in synthetic biology at UC Berkeley; increase multidisciplinary collaborations at UC Berkeley on synthetic biology; and introduce students to a wide perspective of SB projects and innovators as well as policy, legal, and ethical experts.
Terms offered: Prior to 2007
Explore strategies for maximizing the economic and societal benefits of synthetic biology and minimizing the risks; create "seedlings" for future research projects in synthetic biology at UC Berkeley; increase multidisciplinary collaborations at UC Berkeley on synthetic biology; and introduce students to a wide perspective of SB projects and innovators as well as policy, legal, and ethical experts.
Implications and Applications of Synthetic Biology: Read More [+]
Rules & Requirements
Prerequisites: Consent of instructor
Hours & Format
Fall and/or spring: 15 weeks - 2 hours of lecture and 1 hour of discussion per week
Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructors: Arkin, Keasling
Also listed as: BIO ENG C230
Implications and Applications of Synthetic Biology: Read Less [-]
Implications and Applications of Synthetic Biology:

Terms offered: Spring 2007
Explore strategies for maximizing the economic and societal benefits of synthetic biology and minimizing the risks; create "seedlings" for future research projects in synthetic biology at UC Berkeley; increase multidisciplinary collaborations at UC Berkeley on synthetic biology; and introduce students to a wide perspective of SB projects and innovators as well as policy, legal, and ethical experts.

Rules & Requirements
Prerequisites: Consent of instructor

Hours & Format
Fall and/or spring: 15 weeks - 2 hours of lecture and 1 hour of discussion per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructors: Arkin, Keasling
Also listed as: BIO ENG C230

Implications and Applications of Synthetic Biology: Read More [+]

Applied Spectroscopy:

Terms offered: Spring 2009, Spring 2007, Spring 2002
After a brief review of quantum mechanics and semi-classical theories for the interaction of radiation with matter, this course will survey the various spectroscopies associated with the electromagnetic spectrum, from gamma rays to radio waves. Special emphasis is placed on application to research problems in applied and engineering sciences. Graduate researchers interested in systematic in situ process characterization, analysis, or discovery are best served by this course.

Rules & Requirements
Prerequisites: Graduate standing in engineering, physics, chemistry, or chemical engineering; courses: quantum mechanics, linear vector space theory

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructor: Reimer
Also listed as: AST C295R

Applied Spectroscopy: Read Less [-]
CHM ENG C295Z Energy Solutions: Carbon Capture and Sequestration 3 Units
Terms offered: Fall 2019, Fall 2018, Spring 2017, Spring 2015, Spring 2014, Spring 2013
After a brief overview of the chemistry of carbon dioxide in the land, ocean, and atmosphere, the course will survey the capture and sequestration of CO2 from anthropogenic sources. Emphasis will be placed on the integration of materials synthesis and unit operation design, including the chemistry and engineering aspects of sequestration. The course primarily addresses scientific and engineering challenges and aims to engage students in state-of-the-art research in global energy challenges.

Energy Solutions: Carbon Capture and Sequestration: Read More [+]

Rules & Requirements
Prerequisites: Chemistry 4B or 1B, Mathematics 1B, and Physics 7B, or equivalents

Hours & Format
Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Letter grade.
Instructors: Bourg, DePaolo, Long, Reimer, Smit
Also listed as: CHEM C236/EPS C295Z

CHM ENG 296 Special Study for Graduate Students in Chemical Engineering 1 - 6 Units
Terms offered: Spring 2016, Fall 2015, Spring 2015
Special laboratory and theoretical studies.

Special Study for Graduate Students in Chemical Engineering: Read More [+]

Rules & Requirements
Prerequisites: Consent of instructor
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 0 hours of independent study per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: The grading option will be decided by the instructor when the class is offered.

CHM ENG 298 Seminar in Chemical Engineering 1 Unit
Terms offered: Spring 2016, Fall 2015, Spring 2015
Lectures, reports, and discussions on current research in chemical engineering. Sections are operated independently and directed toward different topics.

Seminar in Chemical Engineering: Read More [+]

Rules & Requirements
Prerequisites: Open to properly qualified graduate students with consent of instructor
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Offered for satisfactory/unsatisfactory grade only.

CHM ENG 298C Colloquium in Chemical Engineering 1 - 2 Units
Terms offered: Fall 2019, Spring 2019, Fall 2018
Lectures, reports, and discussions on current research in chemical engineering.

Colloquium in Chemical Engineering: Read More [+]

Rules & Requirements
Prerequisites: Open to properly qualified graduate students with consent of instructor
Repeat rules: Course may be repeated for credit without restriction.

Hours & Format
Fall and/or spring: 15 weeks - 2-3 hours of colloquium per week

Additional Details
Subject/Course Level: Chemical & Biomolecular Engineering/Graduate
Grading: Offered for satisfactory/unsatisfactory grade only.

**CHM ENG 299 Research in Chemical Engineering 1 - 12 Units**
Terms offered: Fall 2019, Spring 2019, Fall 2018
Research.
Research in Chemical Engineering: Read More [+]

**Rules & Requirements**

**Prerequisites:** Consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**Hours & Format**

*Fall and/or spring:* 15 weeks - 1-12 hours of independent study per week

*Summer:* 6 weeks - 2.5-30 hours of independent study per week
8 weeks - 1.5-22.5 hours of independent study per week
10 weeks - 1.5-18 hours of independent study per week

**Additional Details**

**Subject/Course Level:** Chemical & Biomolecular Engineering/Graduate

**Grading:** Letter grade.

Research in Chemical Engineering: Read Less [-]

**CHM ENG 300 Professional Preparation: Supervised Teaching of Chemical Engineering 2 Units**
Terms offered: Spring 2019, Spring 2016, Fall 2015
Discussion, problem review and development, guidance of large scale laboratory experiments, course development, supervised practice teaching.
Professional Preparation: Supervised Teaching of Chemical Engineering: Read More [+]

**Rules & Requirements**

**Prerequisites:** Graduate standing, appointment as a Graduate Student Instructor, or consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**Hours & Format**

*Fall and/or spring:* 15 weeks - 0 hours of independent study per week

**Additional Details**

**Subject/Course Level:** Chemical & Biomolecular Engineering/Professional course for teachers or prospective teachers

**Grading:** Offered for satisfactory/unsatisfactory grade only.

Professional Preparation: Supervised Teaching of Chemical Engineering: Read Less [-]

**CHM ENG 375 Professional Preparation: Supervised Teaching of Chemical Engineering 2 Units**
Terms offered: Fall 2019, Fall 2018, Fall 2015
Discussion, problem review and development, guidance of large scale laboratory experiments, course development, supervised practice teaching.
Professional Preparation: Supervised Teaching of Chemical Engineering: Read More [+]

**Rules & Requirements**

**Prerequisites:** Graduate standing, appointment as a Graduate Student Instructor, or consent of instructor

**Repeat rules:** Course may be repeated for credit without restriction.

**Hours & Format**

*Fall and/or spring:* 15 weeks - 0 hours of independent study per week

**Additional Details**

**Subject/Course Level:** Chemical & Biomolecular Engineering/Graduate

**Grading:** Offered for satisfactory/unsatisfactory grade only.

Professional Preparation: Supervised Teaching of Chemical Engineering: Read Less [-]

**CHM ENG 602 Individual Studies for Graduate Students 1 - 8 Units**
Terms offered: Fall 2019, Spring 2019, Fall 2018
Individual study in consultation with the major field adviser for qualified students to prepare themselves for the various examinations required of candidates for the Ph.D.
Individual Studies for Graduate Students: Read More [+]

**Rules & Requirements**

**Prerequisites:** Graduate standing in Ph.D. program

**Credit Restrictions:** Course does not satisfy unit or residence requirements for doctoral degree.

**Repeat rules:** Course may be repeated for credit without restriction.

**Hours & Format**

*Fall and/or spring:* 15 weeks - 0 hours of independent study per week

**Additional Details**

**Subject/Course Level:** Chemical & Biomolecular Engineering/Graduate examination preparation

**Grading:** Offered for satisfactory/unsatisfactory grade only.

Individual Studies for Graduate Students: Read Less [-]